DEVELOPMENT OF A (GREEN) ROOF ENVIRONMENTAL MONITORING AND METEOROLOGICAL NETWORK IN NEW YORK CITY

2nd International Conference on COUNTERMEASURES TO Urban Heat Islands

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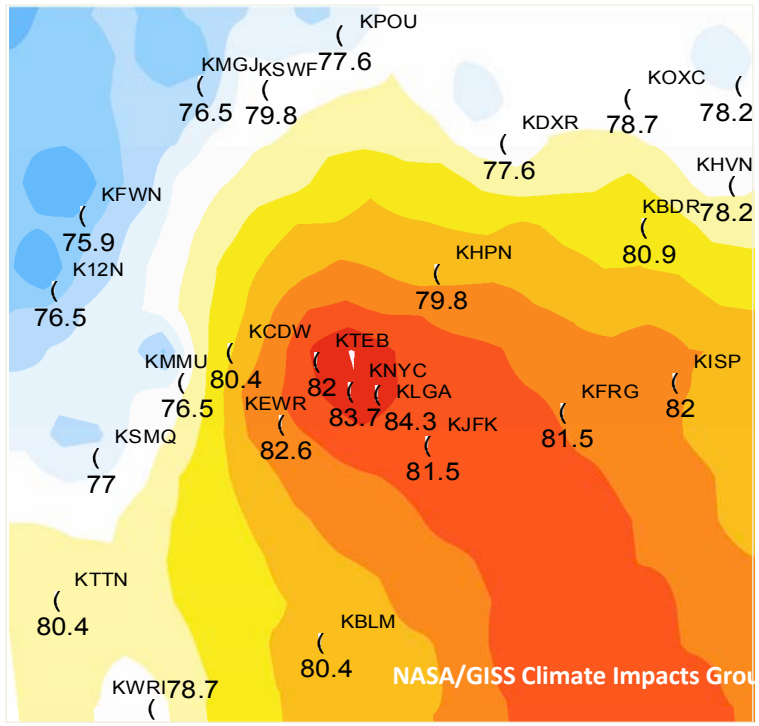
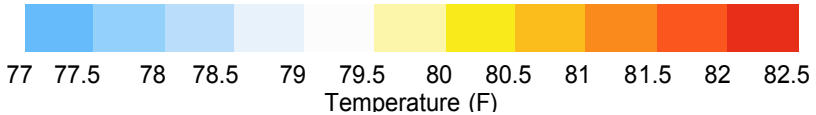
New York's Urban Heat Island

Air Temperature August 14, 2002,

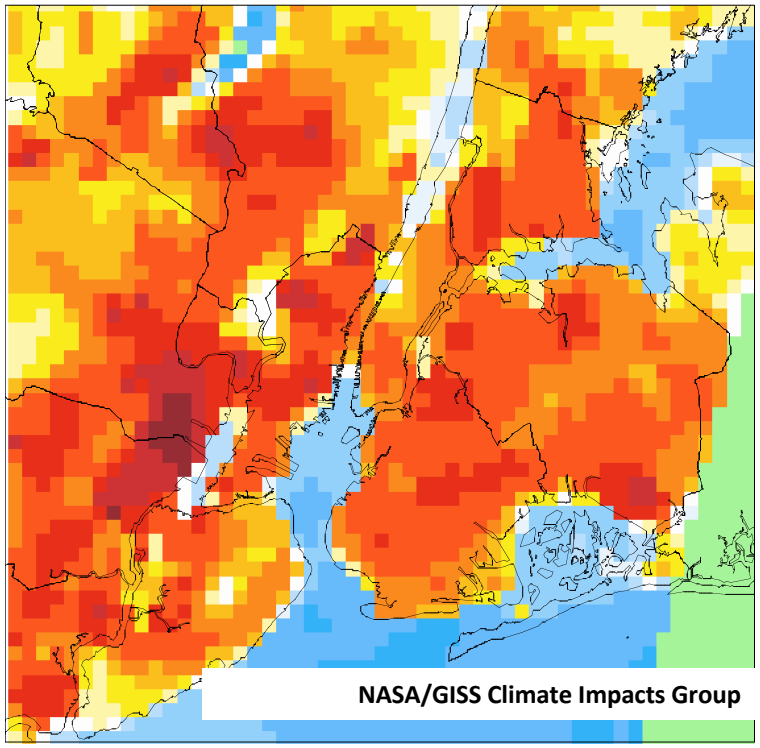
6:00 AM



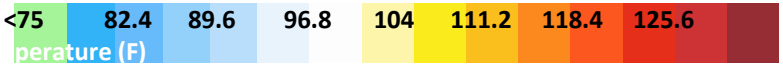


Surface Temperature August 14, 2002,

10:30 AM

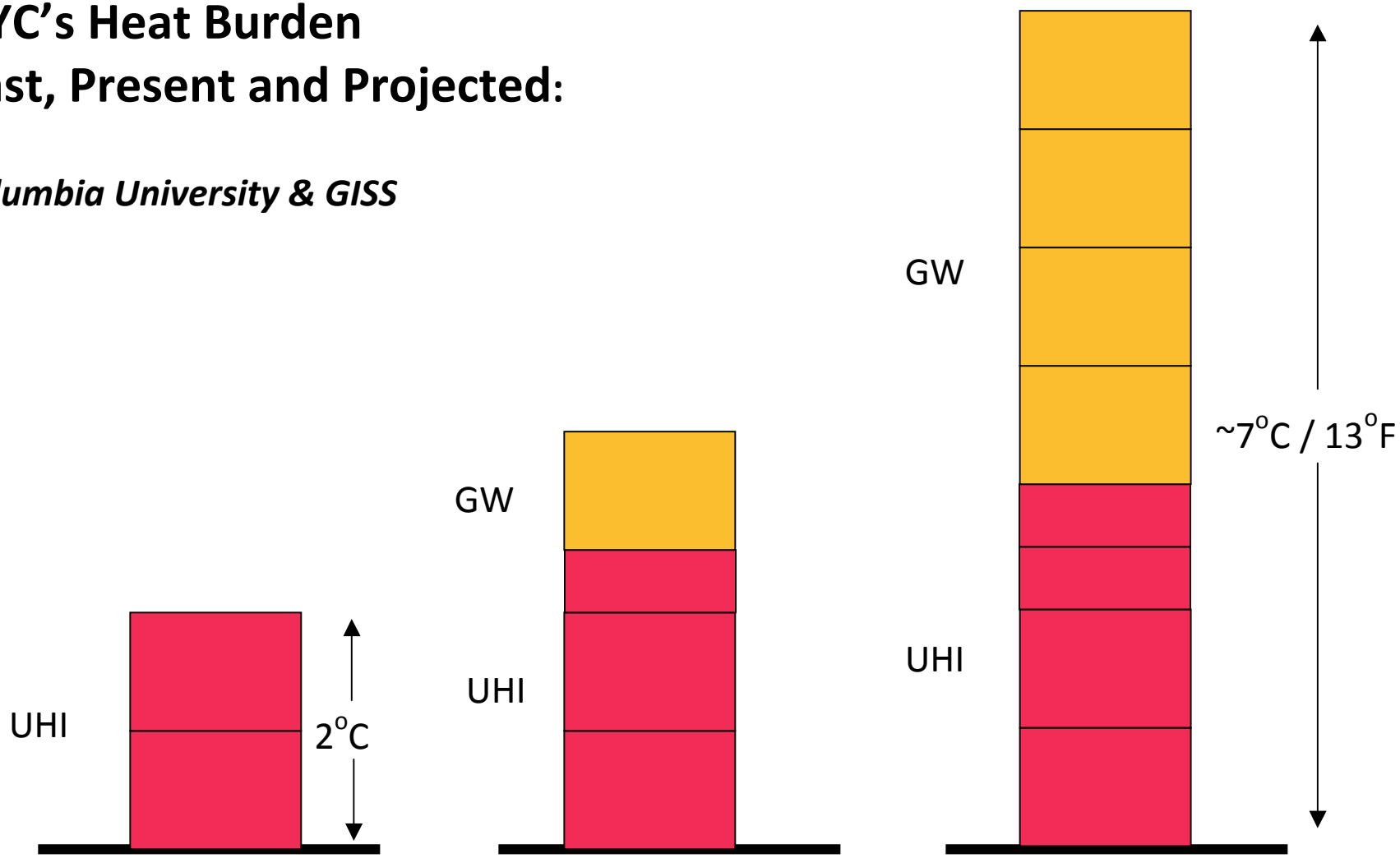


NASA/GISS Climate Impacts Group



NYC's Heat Burden
Past, Present and Projected:

Columbia University & GISS



1900

7 days above 90°F

2000

14 days above 90°F

3-4 days above 95°F

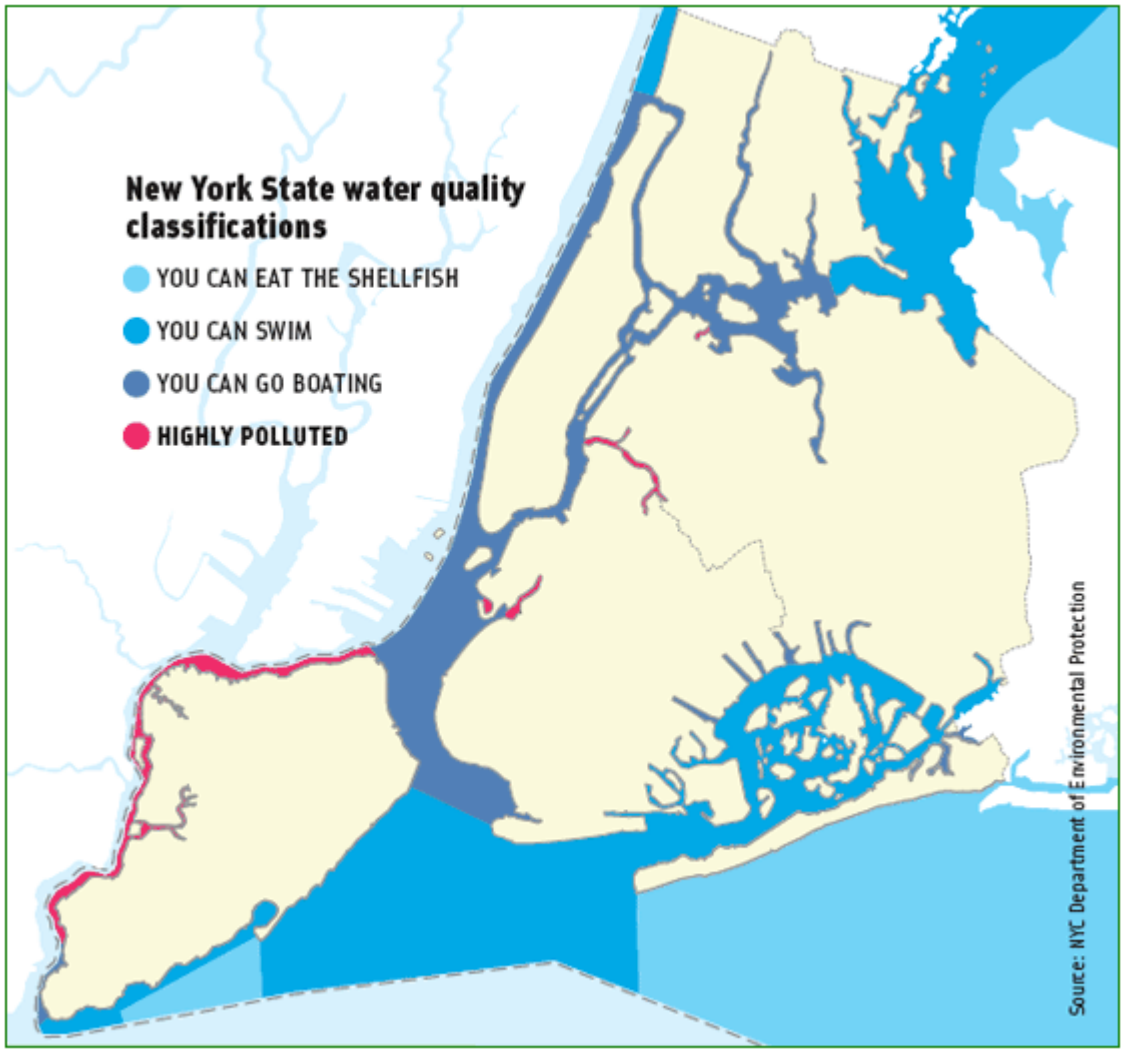
2080

Most of Summer above 90°F

17-50 days above 95°F

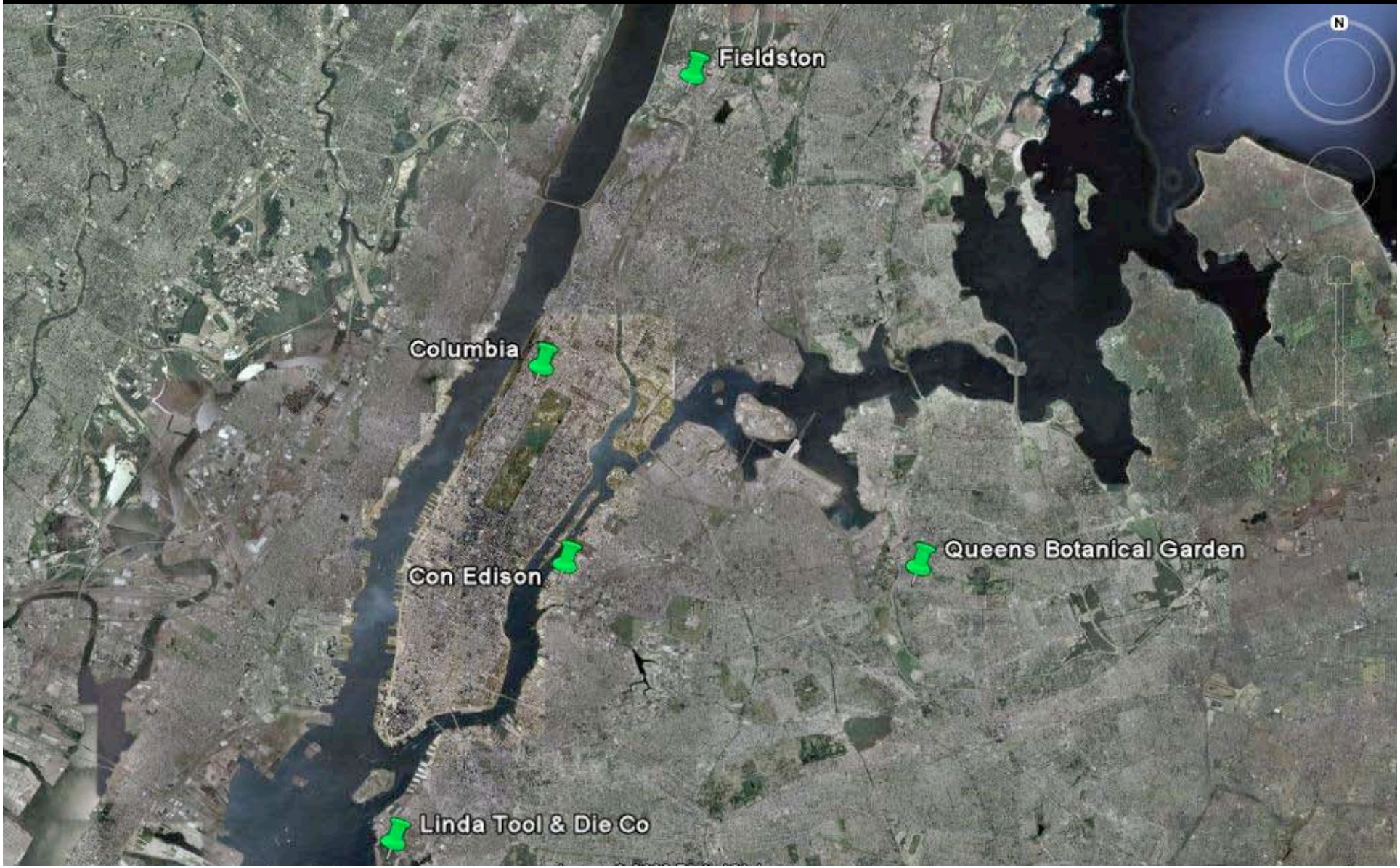
NYC Is An Urban Runoff Island Too

NY City's Water Quality Classifications

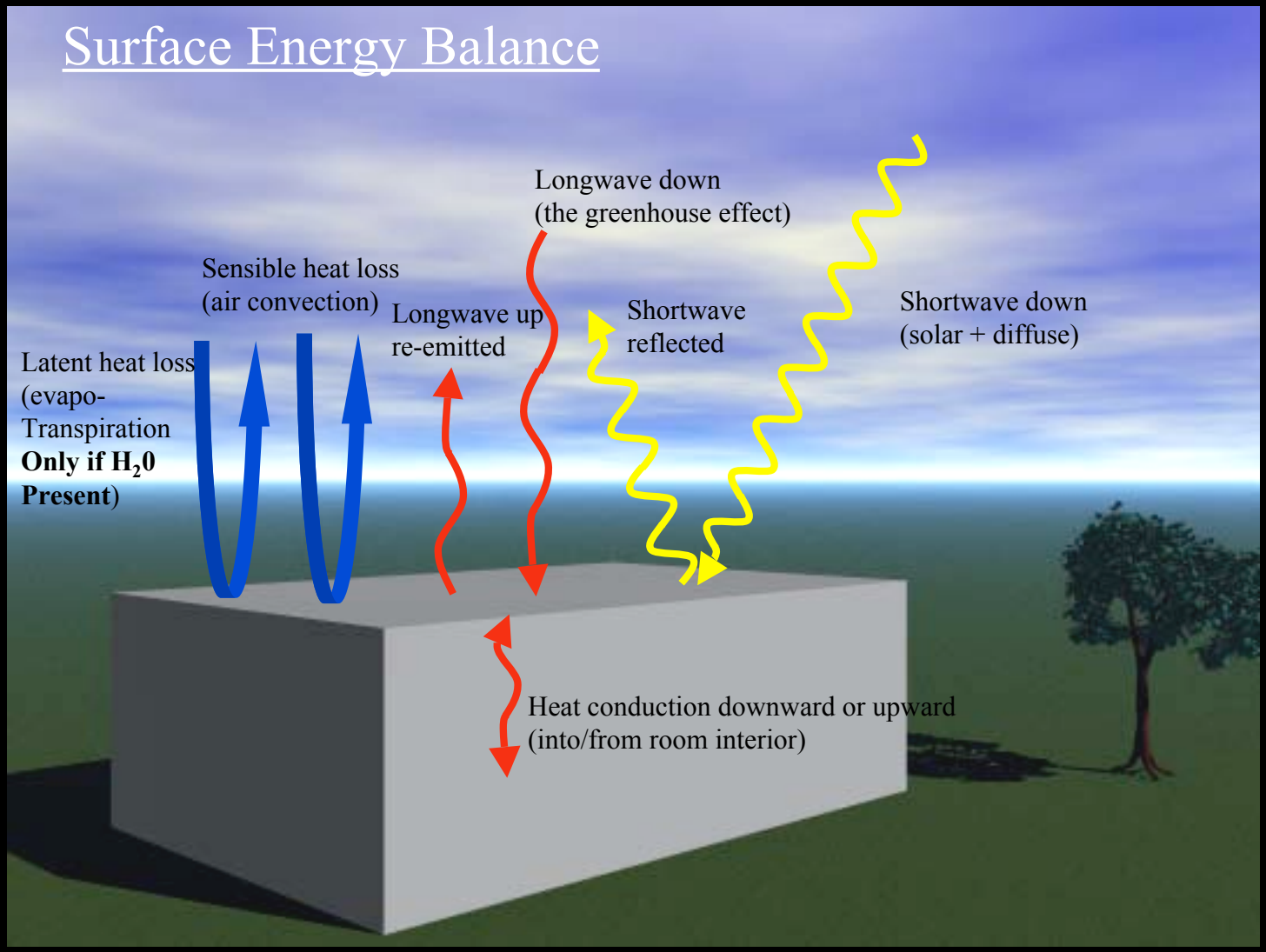


Mayor's 2030 PlaNYC Goal # 10: ***Open 90% of our waterways for recreation by reducing water pollution…***

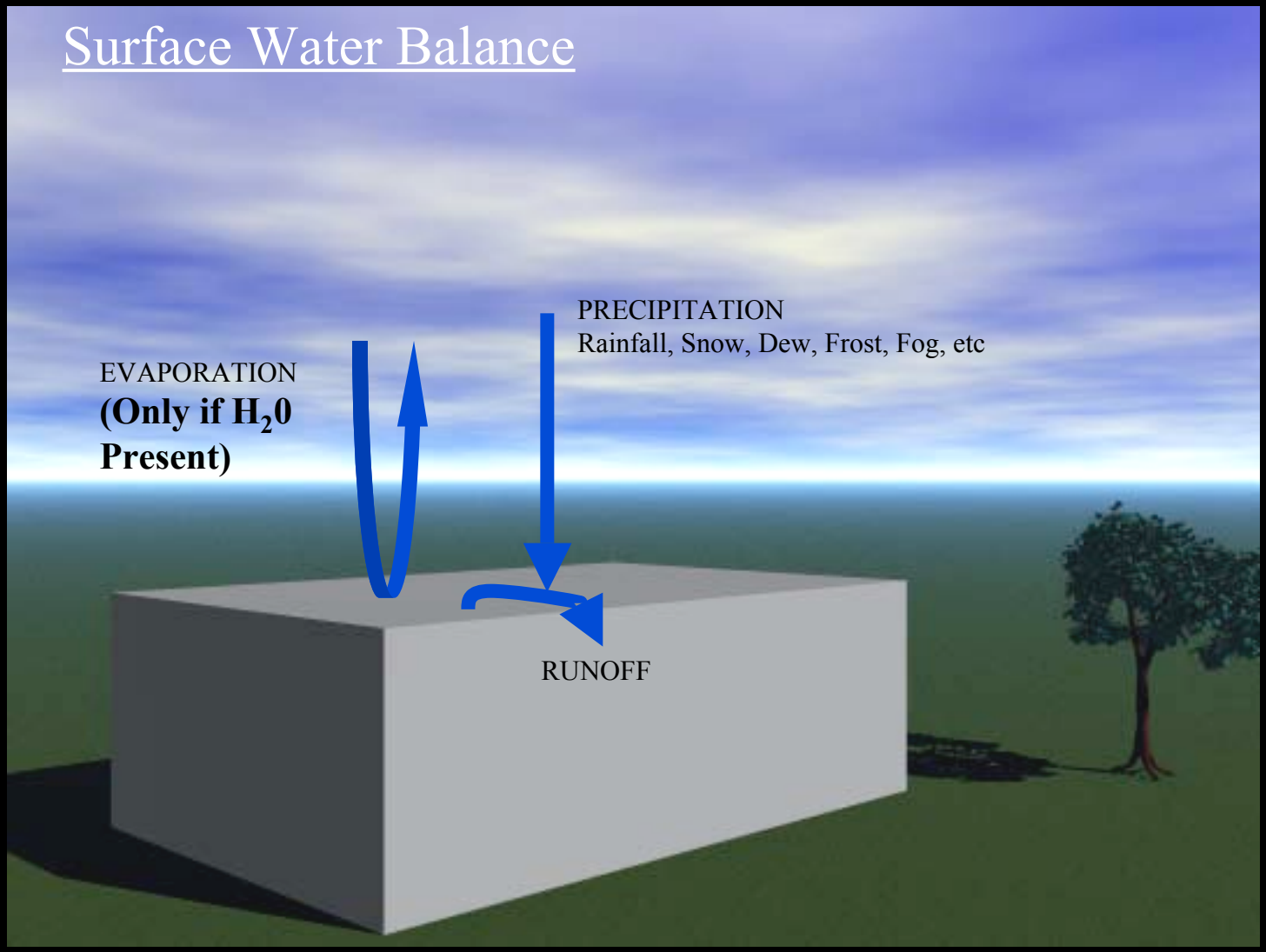
Columbia University Green Roof "Met Net"



Surface Energy Balance

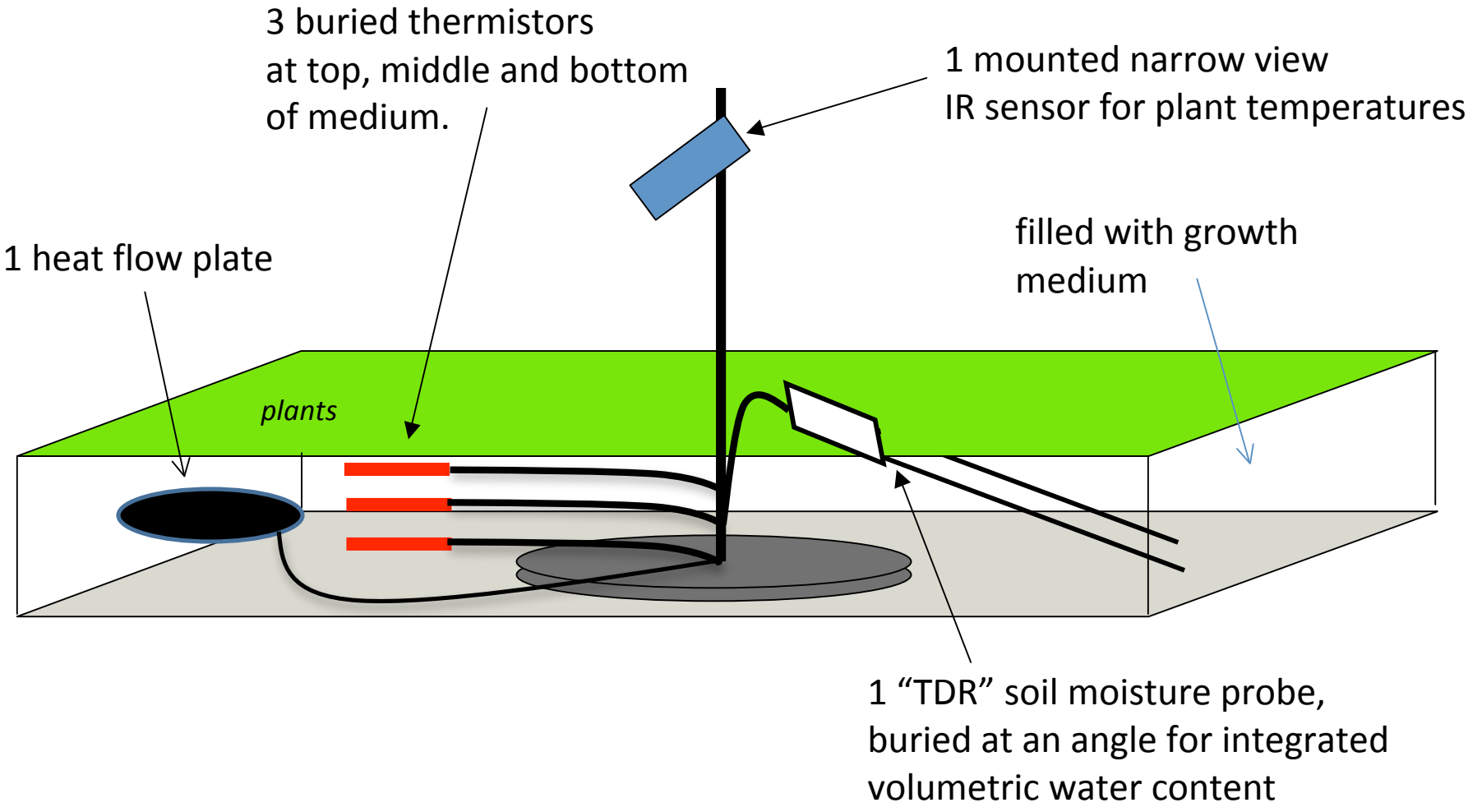


Surface Water Balance



Green Roof Monitoring Stands

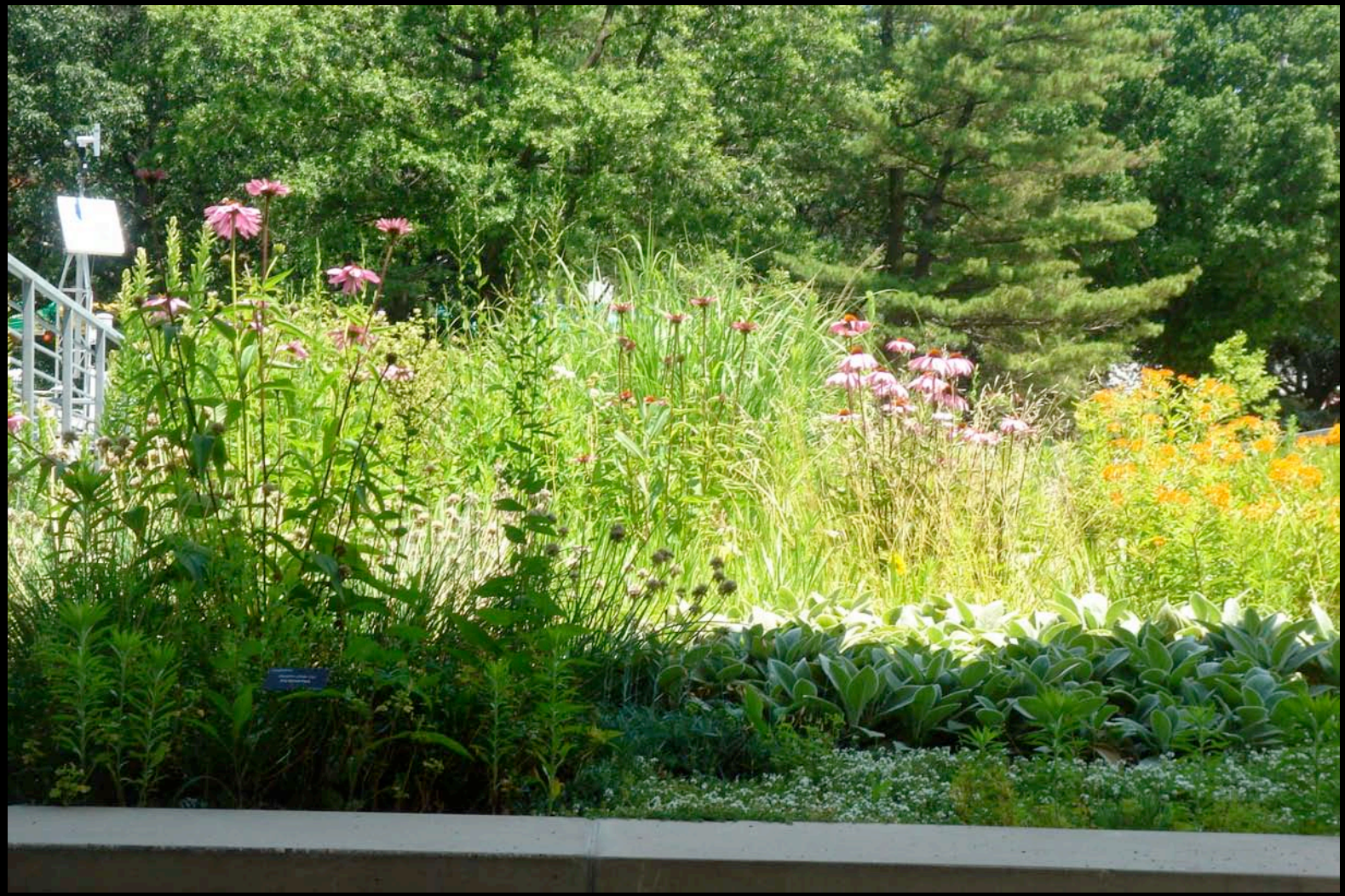
Sets of the instrumentation are deployed at different locations on the green roof



Ethical Culture Fieldston School, Bronx, New York

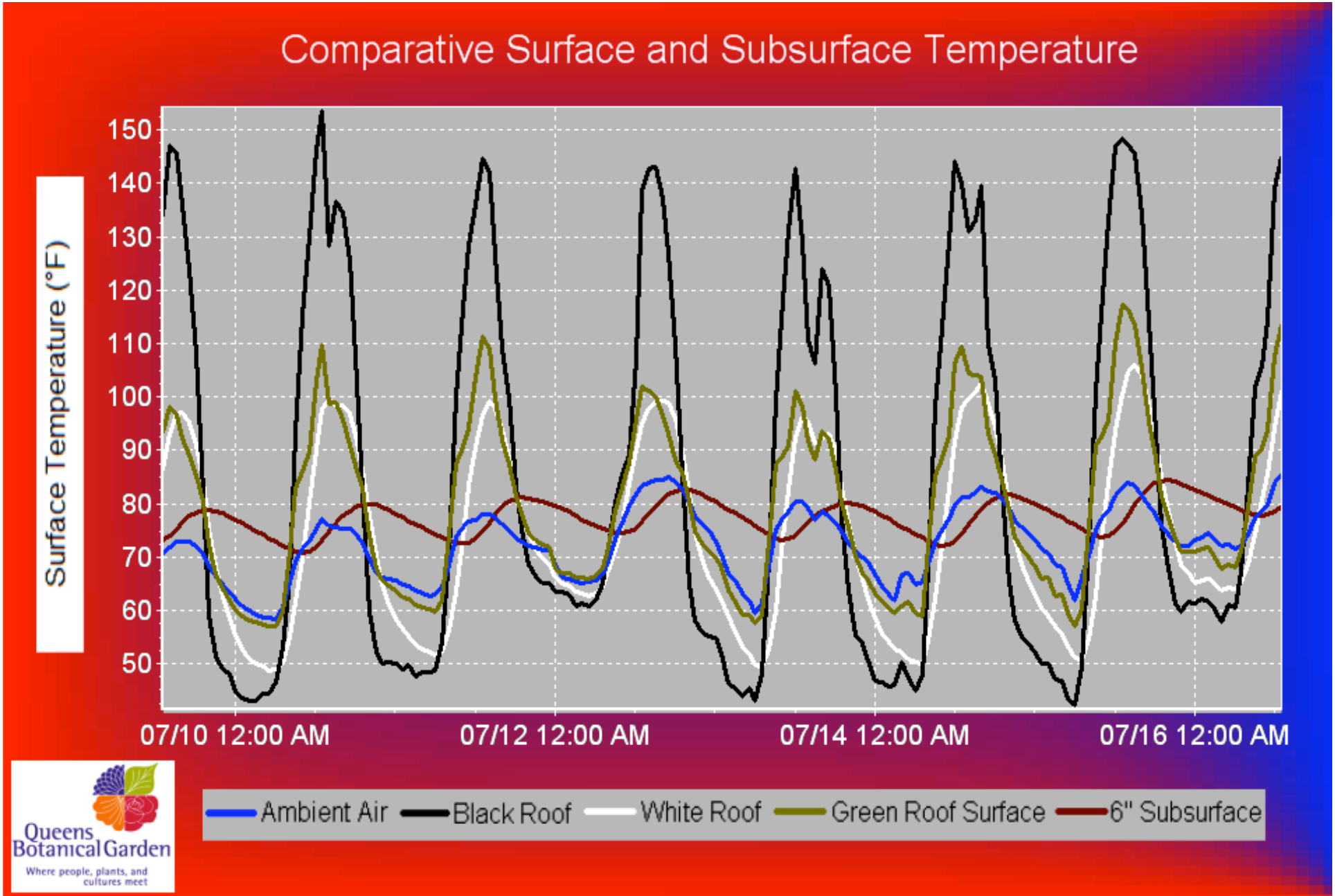
Columbia University, New York

Queens Botanical Garden, New York



Con Edison Building, LIC, New York

Con Edison Building, LIC, New York



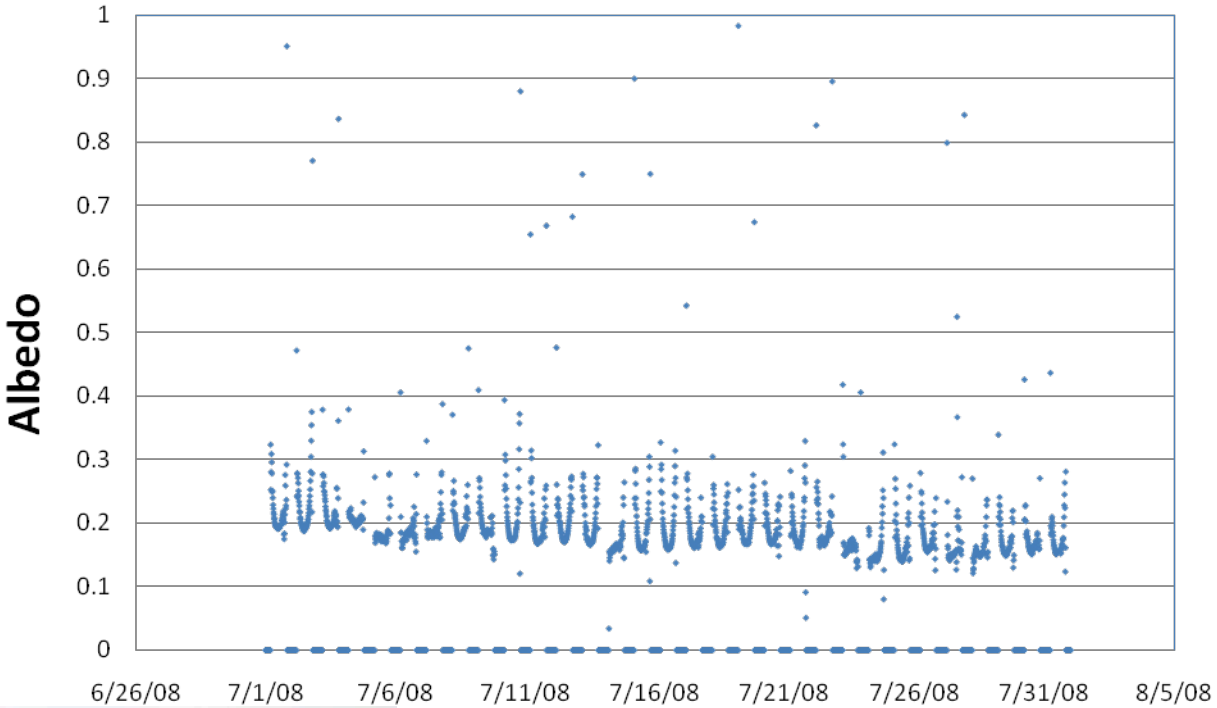
Web link: ccsr.columbia.edu/cig/greenroofs/index.html

Water Runoff Being Measured With Scale Model

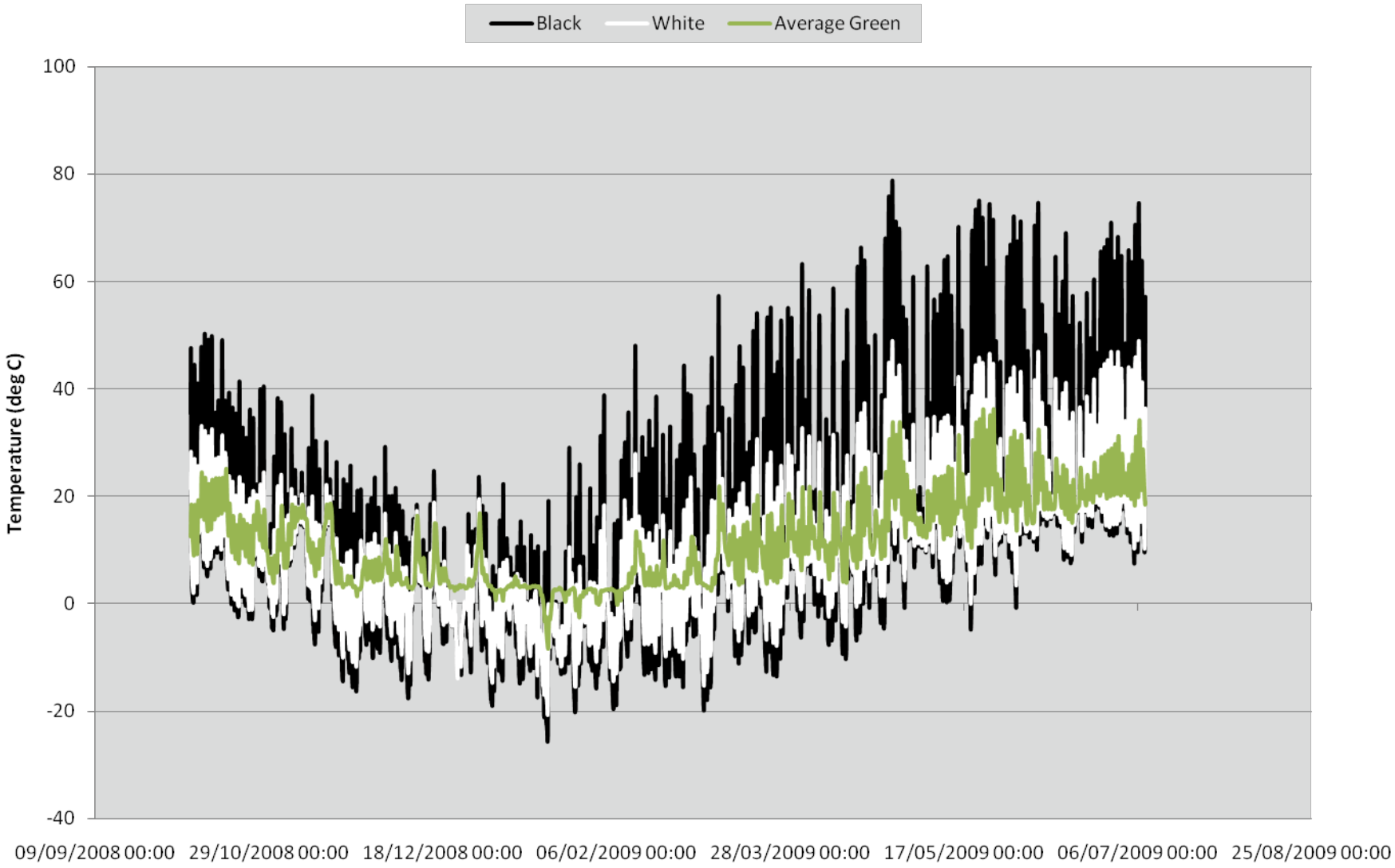
We Have Successfully Established Endangered Native Grasslands On A Roof In Bronx in 6-inches of medium

Green Roof Albedo

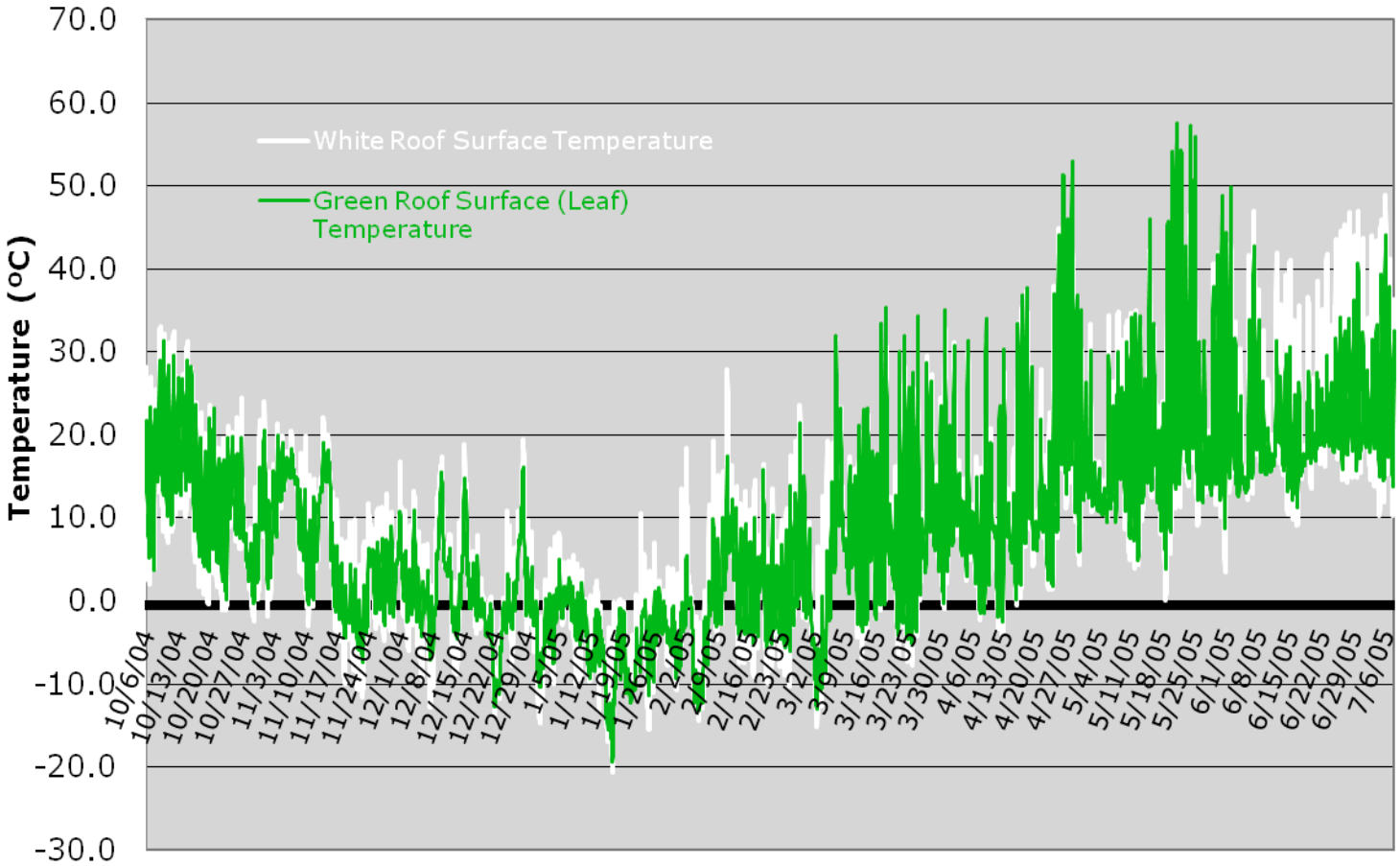
average = 0.20



Comparative Roof Membrane Temperatures



Comparative White Surface and Green Leaf Temperatures



Black, White, Green Roof Heating Energy Costs
for 1000 m² roof with R-20 Insulation Board

WINTER (DJF) HEAT ENERGY ANALYSIS		Heating Energy & Costs for 1000 m² Roof			
	Avg Heat Flux Loss (W/m^2)	Natural Gas (kW·h)	Energy Cost	Heating Oil (kW·h)	Energy Cost
Northern Green (unshaded)	-4.16	13838.45	$600.11	10106.73	$555.62
Southern Green (shaded)	-5.21	17316.53	$750.93	12646.90	$695.27
White Roof (lower green model)	-5.73	19042.85	$825.80	13907.70	$764.58
Black Roof (lower green model)	-5.90	19611.51	$850.50	14323.01	$787.41
White Roof (fixed lower model)	-6.34	21233.31	$920.79	15507.50	$852.53
Black Roof (fixed lower model)	-6.56	21801.97	$945.45	15922.79	$875.34

Heat Savings: $330/yr

Caveat: this green roof is less that 1 yr old and is a tray system – older &/or layered green roofs will probably do better.

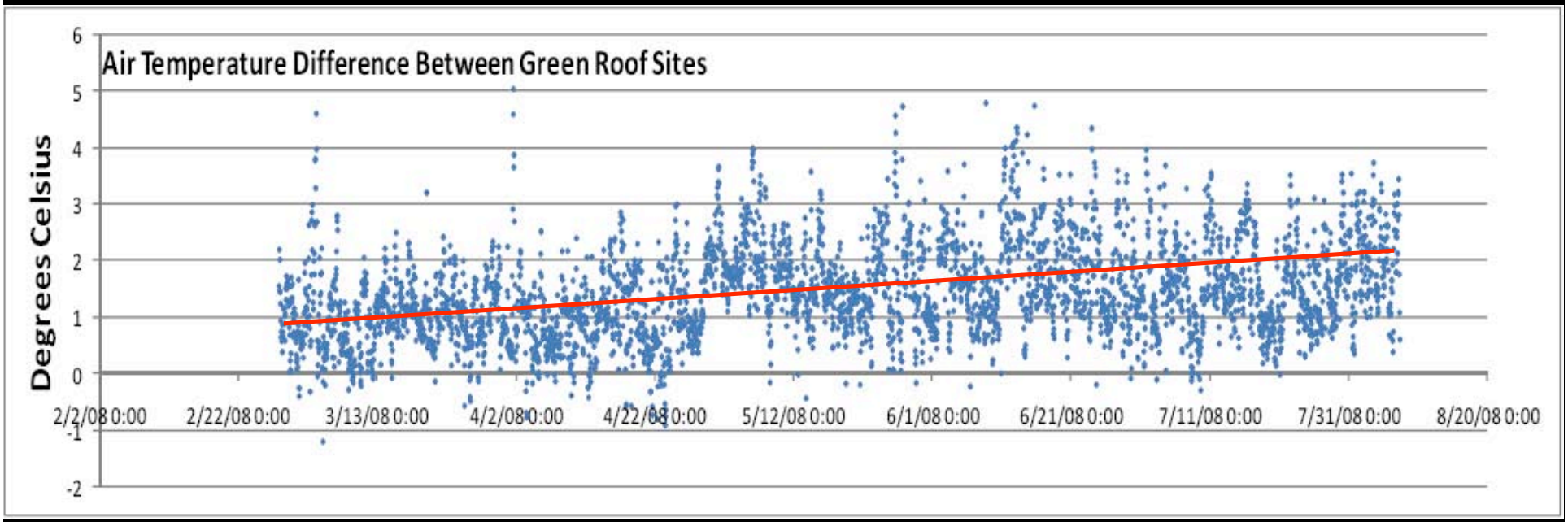
Black, White, Green Roof Cooling Energy Costs
for 1000 m² roof with R-20 Insulation Board

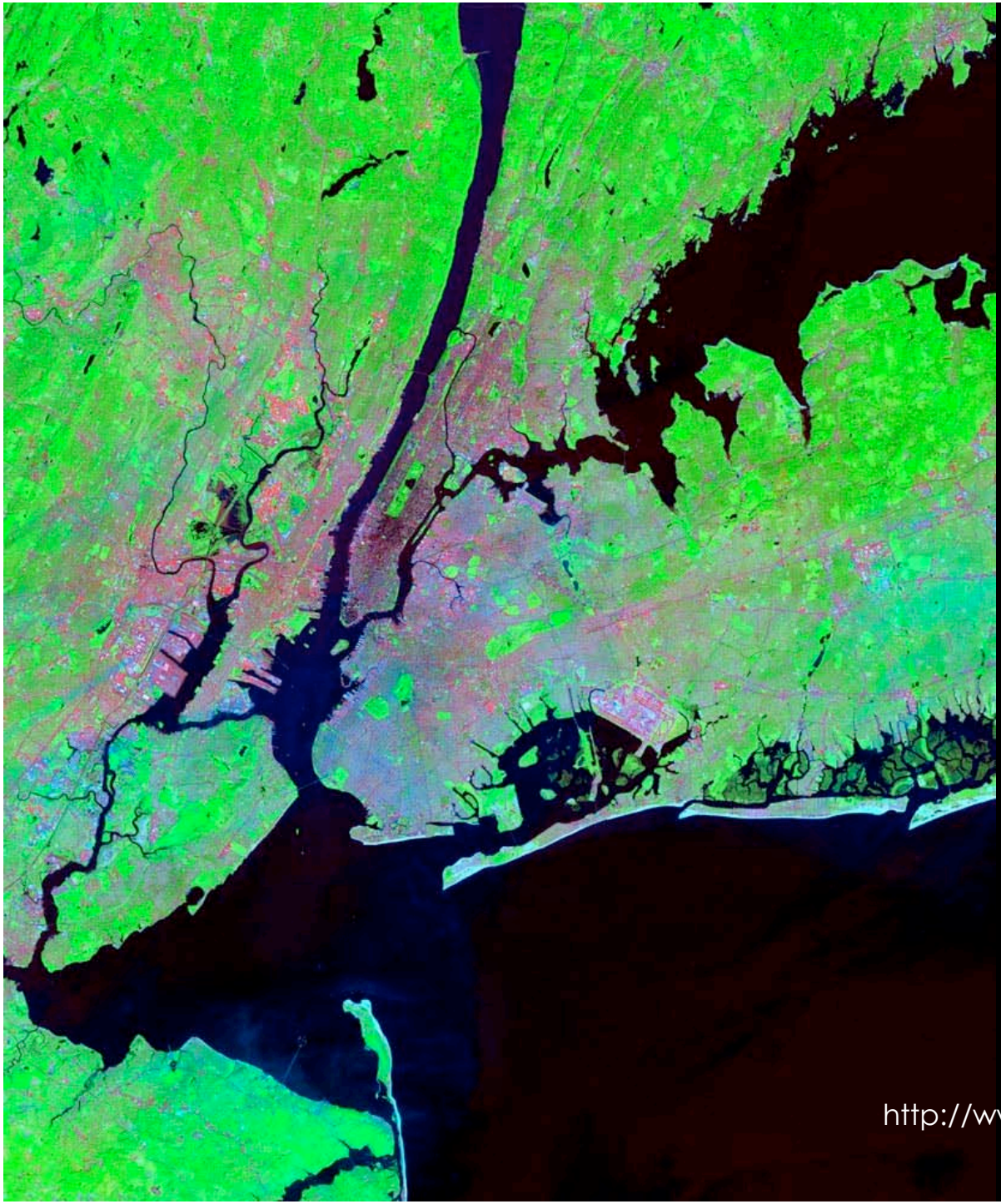
SUMMER (JJA) COOLING ENERGY ANALYSIS		Cooling Energy & Costs for 1000 m² Roof	
	Avg. Heat Flux Gain (W/m^2)	Cooling Energy (kW·h)	Energy Cost
Northern Green (unshaded)	+0.41	234.57	$42.193
Southern Green (shaded)	+0.18	104.55	$18.80
White Roof (Lower Green Model)	+0.70	402.55	$72.40
Black Roof (Lower Green Model)	+2.13	1232.87	$221.74
White Roof (Fixed Lower Model)	+1.14	657.84	$118.32
Black Roof (Fixed Lower Model)	+2.57	1488.16	$267.66

Cooling Savings: $225/yr

Annual Roof Energy Savings By Switch from Black to Green is < $1,000.00

Air Temperature Difference Between Bronx and Columbia Weather Stations (only ~10 km separation between sites)

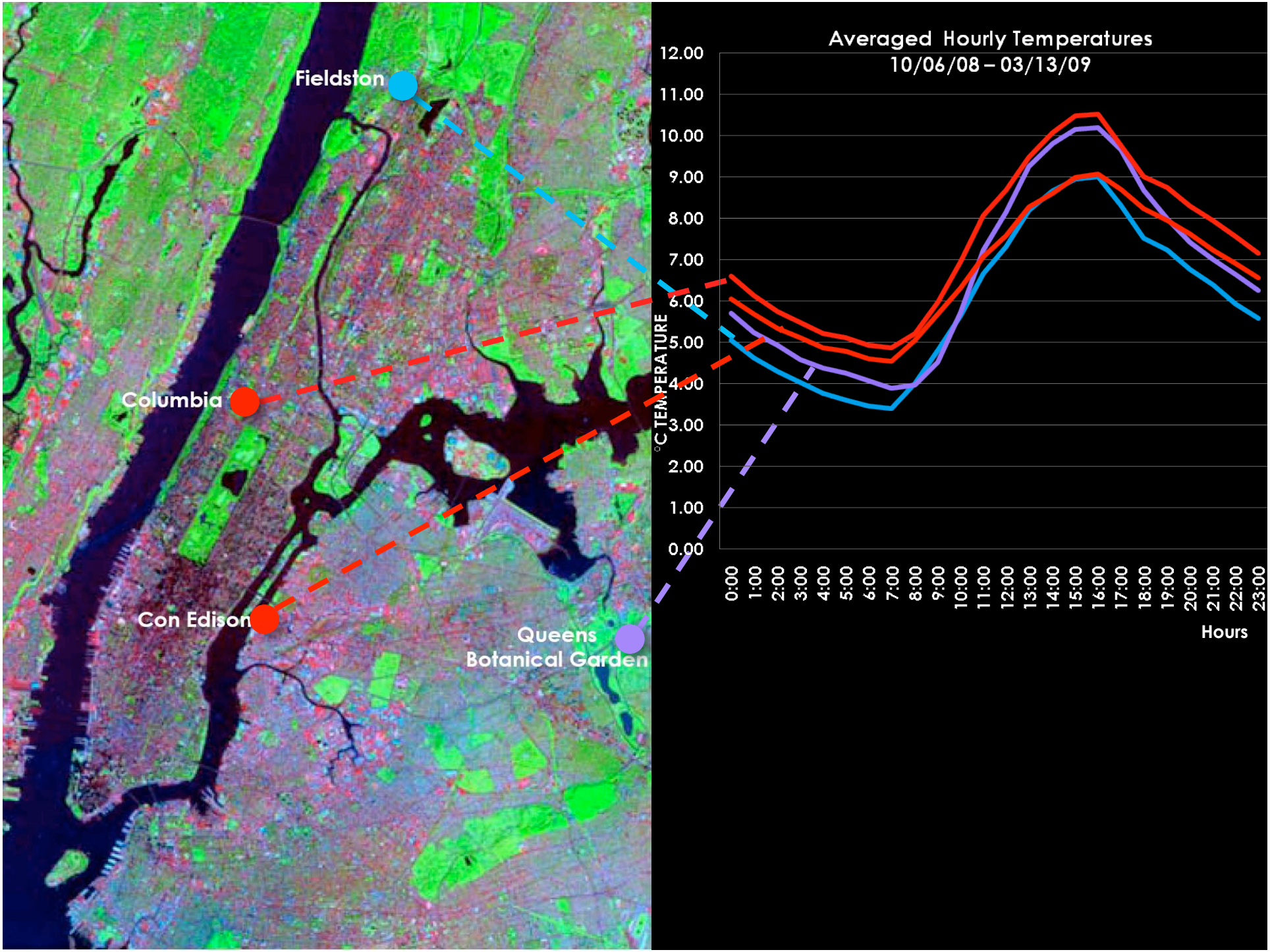




Vegetation map for New York Metropolitan area

Source:

Christopher Small
Lamont Doherty Earth Observatory
Columbia University
NYC USA
http://www.ldeo.columbia.edu/~small/Urban.html


Fieldston
Columbia
Con Edison
Queens
Botanical Garden
Averaged Hourly Temperatures
10/06/08 – 03/13/09
°C TEMPERATURE
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
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13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
Hours

Conclusions

-**Greenroof MetNet has become a versatile outdoor laboratory:**

safe, secure, restoring endangered habitat, doing insect surveys, testing sample temps and albedos, superior site for urban rooftop weather stations

– Green and white roof temperature reductions are dramatic in summer

– Not seeing any winter-heat penalty for white TPO roofs.

– Energy savings from green and white roofs with good insulation are modest. (However if air-intake for cooling exists on rooftop, additional savings will occur.)

– MetNet is revealing small scale variations in UHI that correlate well with urban vegetation.